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THE REMOVAL OF STONE IN THE BLADDER.[1]

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IT is my purpose to demonstrate:

1. The measured crushing resistance of vesical calculi.
2. The measured strength of the lithotrite.
3. The lithotrite from a mechanical point of view.
4. A new lithotrite.

Given the problem—a stone in the bladder, a limited viaduct to reach it: remove the stone without injuring the parts. There are two unknown factors in this problem: First, the crushing resistance of the stone, and second, the strength of the lithotrite used in reducing the stone so that it may be removed with facility. Knowing the crushing resistance of the strongest vesical calculus in our possession, we are in a position to proceed to so construct a lithotrite that we can successfully crush and safely remove such a stone were we to meet with it in the human bladder. So far as I know, the exact crushing resistance of a vesical calculus has never been stated by any writer. Such vague statements as "very hard," "very tough," "very large," etc., have been used in describing stones, but the measured crushing resistance of any stone taken from the human bladder has always been overlooked. The same may be said of the lithotrite. "Very strong," "very powerful," etc., have been the vague terms used in describing it; but its measured strength computed by any unit has never been stated. In order to inform myself exactly on these points I addressed a letter to the Librarian of the Surgeon-General's Office, Washington, asking for any information whatever the Library contained in regard to them, and his reply was that the Library contained nothing relating to the matter.

It is manifest, therefore, that I have entered an entirely new field of investigation. Now, with a perfect disposition to respect the written law of this body to study economy of time, I shall strive to aim at all practicable condensation and brevity. A very liberal expenditure, however, is at times demanded by the wisest economy; and if it shall be found—as I fear it may, from the almost elementary manner in which, to meet all exigencies, the questions that arise must be discussed—that my own outlay offends against the letter of the law, I hope it also will be found that it is in harmony with its spirit.

In order to attain the necessary knowledge for the solution of the problem in question, it is necessary first to measure the crushing resistance of a large number of stones taken from the human bladder, a very large number of every size, embracing the hardest, toughest, and largest specimens, for it must be borne in mind that it is especially these that we seek to investigate, rather than those that are small and readily broken by very moderate pressure. So far I have been able to collect from all sources only 184 human vesical calculi for this investigation.

The table herewith annexed, in which the results are given, is so arranged that any number can be added. I propose to continue these investigations, and from time to time I shall add and publish the results observed. I shall begin my task impressed with that fine saying of Coleridge: "The conditions of science should be weighed in the scales of a jeweller, and not like the commodities of the market on the weigh-bridge of common prejudice and vulgar error."

We find that the 184 vesical calculi tabulated are divided as follows:

Oxalate of lime	55
Phosphate of lime	64
Uric acid	27
Oxalate and phosphate mixed	15
Uric acid and phosphate mixed	8
Uric acid and oxalate mixed	7
Oxalate, phosphate, and uric acid mixed	4
Combustible, requiring further examination	2
Carbonate of lime and oxalate	1
Cystin	1
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Had time permitted, the grouping of the calculi in the table below would have been made on the basis of their chemical constitution, as indicated in the foregoing summary.

At some future time this grouping will be arranged and all additions to it will be made upon this basis.

[1] Read before the American Surgical Association, June 1st, 1894, during the Triennial Congress of American Physicians and Surgeons.

TABLE OF THE MEASURED CRUSHING RESISTANCE OF 184 VESICAL CALCULI.

No.	Appearance of calculus.	Composition of calculus.	Diameters, in millimeters.	Volume, in cubic centimeters.	Weight, in ounces and grains.	Specific gravity (approximate).	Axis of holding between jaws of lithotrite.	Actual crushing resistance of calculus, in lbs., with Forbes' lithotrite; friction of lithotrite and testing apparatus deducted.	Direction of fracture to line of force applied.	Time slowly increasing pressure was applied to calculus, in min.	Number of fragments.	Flying fragments.	Distance fragments were thrown, in inches.	Size of lithotrite used (French scale).	Impaction of lithotrite, measured by increased size, in degrees of French scale.	Point of fracture in lithotrite.	Calculus loaned by
1	Smooth	Inside oxalate, outside phosphate.	32-38-54	36	1–392	1.577	Short	264.25	Coincident	10	2	None	None	33			
2	"	Uric acid . .	14-25-31	6.7	0–130	1.272	"	105.00	Radiating	1	Many	"	"	30			
3	"	Phosphate of lime	25-33-39	17	0–368	1.410	"	60.46	Coincident	½	3	"	"	30			
4	Granulated	Uric acid . .	20-25-36	8.5	0–180	1.379	"	150.00	"	4	5	Some	18	30			
5	Smooth	Phosphate . .	18-22-34	5.5	0–155	1.836	"	30.23	"	¼	3	None	None	30			
6	Granulated	Oxalate . .	25-29-32	10.5	0–233	1.445	"	50.39	"	1	2	"	"	30			
7	Smooth	Phosphate . .	15-26-32	6	0–145	1.574	"	140.00	"	4	2	"	"	30			
8	"	Oxalate . .	14-21-25	4.5	0–116	1.685	"	162.00	Crucial	4	4	"	"	30			
9	"	Phosphate . .	14-24-28	5	0–114	1.485	"	90.00	Coincident	1¾	4	"	"	30			
10	"	" . .	34-42-54	39	1–427	1.598	"	79.50	"	4	2	"	"	33			
11	"	" . .	24-32-53	22.5	1–110	1.708	"	59.50	"	1½	2	"	"	33			
12	"	" . .	23-32-55	23.7	1–44	1.440	"	67.00	"	2	2	"	"	33			
13	"	" . .	25-32-41	19.8	0–396	1.302	"	110.50	Radiating	2	4	"	"	33			
14	"	" . .	7-16-32	1.3	0–33	1.654	"	50.00	Coincident	1¾	4	"	"	30			
15	"	" . .	9-17-21	1.1	0–31	1.836	"	62.00	"	2	2	"	"	30			
16	"	Uric acid . .	28-35-38	17	0–413	1.582	"	142.50	"	4	3	"	"	33			
17	"	Oxalate . .	41-57-68	77	3–303	1.474	"	214.00	Radiating	6	4	Two	12	33			
18	"	Phosphate . .	25-35-42	16.9	0–340	1.310	"	79.50	Coincident	3	3	None	None	33			
19	"	" . .	20-22-25	6.2	0–116	1.218	"	66.00	Radiating	1	Many	"	"	30			
20	"	" . .	15-21-24	4.5	0–68	1.085	"	65.00	Coincident	1½	2	"	"	30			
21	"	" . .	24-27-28	10.1	0–180	1.173	"	74.00	Radiating	3	5	"	"	30			
22	Nodulated	" . .	35-40-60	34.5	1–99	1.888	"	25.20	Coincident	¾	2	"	"	30			
23	Smooth	Uric acid . .	10-19-23	3.2	0–58	1.178	"	83.00	Radiating	5	Many	"	"	30			
24	"	Phosphate . .	25-28-29	8	0–162	1.311	"	98.00	"	3	4	"	"	30			
25	"	" . .	18-26-37	10.6	0–203	1.241	"	90.00	Coincident	2½	2	"	"	30			
26	"	Oxalate . .	12-21-31	3.6	0–78	1.411	"	60.00	"	2¾	Many	"	"	30			
27	Nodulated	" with littlo uric acid intermixed.	35-39-48	34	1–435	1.753	"	406.00	"	11	2	Two	18	33			
28	Smooth	Phosphate . .	29-44-50	32	1–166	1.335	"	131.25	"	8	3	None	None	33			
29	"	" . .	23-39-45	20.3	0–388	1.245	Intermediate	31.50	"	½	Many	"	"	33			
30	"	Uric acid . .	17-32-40	12.5	0–285	1.485	Short	51.00	"	1½	3	"	"	30			
31	"	Oxalate . .	12-18-22	3	0–61	1.324	"	79.50	"	3	2	"	"	33			
32	"	Inside nric acid, outside phosph.	40-46-78	69.5	2–417	1.290	"	122.25	"	5	Many	"	"	33			
33	"	Phosphate . .	10-18-41	4.2	0–81	1.256	Intermediate	31.50	"	1	2	"	"	33			
34	"	" . .	5-12-17	7	0–12.5	1.163	Short	21.00	"	1	3	"	"	33			
35	"	" . .	48-50-66	79.5	3–270	1.412	"	280.00	"	11	2	"	"	33	None	Noue	Jefferson Medical College
36	"	" . .	15-17-22	3.1	0–50	1.050	"	10.07	"	¼	2	"	"	30			
37	"	Oxalate . .	20-22-38	9.5	0–204	1.302	"	162.00	"	9	5	"	"	30			
38	Rough,	Uric acid . .	42-60-66	79.5	3–459	1.556	"	110.50	"	3	2	"	"	33			
39	" mammillated	Iuside oxalate, outside phosph,	30-44-56	38	2–6	1.655	"	187.86	"	8	3	One	10	33			
40	Smooth	Oxalate . .	26-32-35	14.6	0–311	1.387	"	160.24	"	7	3	Somo	20	33			
41	"	Inside uric acid, outside phosph.	15-20-22	3.7	0–62	1.091	"	50.00	"	1½	4	None	None	30			
42	"	Uric acid . .	18-39-48	17.5	0–117	1.552	"	150.00	"	5¼	2	One	18	30			
43	"	Iuside uric acid, outside phosph.	30-37-59	35.5	1–372	1.563	"	122.25	"	3	2	None	None	33			
44	Smooth, irregular	Inside phosphate with oxalate, outside phosph.	25-34-50	18	0–371	1.342	"	131.25	"	4	2	"	"	33			
45	Smooth, flat	" " "	15-36-39	8.7	0–173	1.295	"	131.25	"	5	2	"	"	33			
46	Rough	Phosphate . .	15-24-30	5	0–90	1.172	"	62.00	"	1½	3	"	"	30			
47	Smooth	Oxalate . .	24-30-45	17.8	0–406	1.485	"	183.62	"	2½	3	Some	18	33			
48	"	Phosphate . .	19-22-34	4.8	0–93	1.262	"	110.00	"	3	2	None	None	30			
49	Lobulated	Uric acid . .	22-29-31	9.8	0–241	1.602	"	122.25	"	3	3	"	"	33			
50	"	" " . .	11-17-18	1.7	0–40	1.533	"	34.12	"	3	3	"	"	33			
51	Smooth	" " . .	10-14-16	1.3	0–29	1.453	"	21.00	"	1	2	"	"	33			
52	"	" " . .	11-12-14	18	0–8	1.384	"	36.74	"	1	2	"	"	33			
53	"	" " . .	7-10-11	0.4	0–10	1.628	"	44.50	"	2	2	"	"	33			
54	"	" " . .	7- 8-10	0.3	0–7	1.521	"	42.00	"	3	Many	"	"	33			
55	"	Inside uric acid, outside phosph.	30-32-43	24	0–479	1.300	"	173.00	"	6	2	"	"	33			
56	Mammillated	Oxalate, bloodclot inside.	20-26-35	10.2	0–194	1.239	"	30.23	"	½	Many	"	"	30			
57	"	Oxalate . .	15-21-27	4.6	0–114	1.614	"	156.00	"	7	2	"	"	33			
58	Smooth	Inside oxalate, middle uric acid, outside phosph.	17-30-38	10.1	0–229	1.477	"	105.00	"	5	2	"	"	30			
59	"	Inside uric acid, outside oxalate.	17-22-27	6	0–133	1.444	"	138.00	"	7	2	"	"	33			
60	"	Phosphate . .	21-31-38	14	0–297	1.382	"	82.00	"	2	4	"	"	33			
61	Granular	Cystin . .	13-20-27	3.7	0–80	1.408	"	62.00	"	1	2	"	"	33			
62	Rough, mammillated	Oxalate . .	17-20-22	3.6	0–87	1.574	"	126.75	"	7½	2	"	"	33			
63	Smooth	Phosphate . .	15-22-26	4.8	0–97	1.316	"	93.87	"	2	2	"	"	33			
64	"	Inside oxalate, outside phosph.	27-32-40	17.2	0–402	1.522	"	187.86	Crucial	8	4	Some	24	33			

No.	Appearance of calculus.	Composition of calculus.	Diameters, in millimeters.	Volume, in cubic centimeters.	Weight, in ounces and grains.	Specific gravity (approximate).	Axis of holding between jaws of lithotrite.	Actual crushing resistance of calculus, in lbs., with Forbes' lithotrite; friction of lithotrite and testing apparatus deducted.	Direction of fracture to line of force applied.	Time slowly increasing pressure was applied to calculus, in min.	Number of fragments.	Flying fragments.	Distance fragments were thrown, in inches.	Size of lithotrite used (French scale).	Impaction of lithotrite, measured by increased size, in degrees of French scale.	Point of fracture in lithotrite.	Calculus loaned by
65	Smooth	Phosphate . .	30-33-35	18.2	0–295	1.055	Short	89.11	Coincident	4	2	None	None	33			
66	"	" . .	17-29-36	10.6	0–241	1.481	"	86.74	"	3	2	"	"	33			
67	"	" . .	15-23-34	5.7	0–112	1.280	"	39.36	"	2	2	"	"	33			
68	"	Combustible, further examination necessary.	21-25-28	8	0–144	1.172	"	42.00	"	1½	2	"	"	33			
69	"	Phosphate . .	30-42-55	37.5	1–379	1.492	"	110.50	"	5	3	"	"	33			
70	Rough	Oxalate . .	20-22-30	7.9	0–170	1.401	"	39.36	"	2	2	"	"	33			
71	Smooth	Phosphate . .	36-38-67	36.5	1–133	1.094	"	140.25	"	8	2	"	"	33			
72	"	Oxalate . .	29-35-40	21.5	1–5	1.469	"	89.11	"	3	2	"	"	33			
73	"	Phosphate . .	24-27-47	16.3	0–345	1.378	"	106.74	"	4½	2	"	"	33			
74	"	"	12-19-29	5	0–88	1.146	"	47.00	"	3	2	"	"	33			
75	Mammillated	Oxalate . .	18-23-25	5.3	0–131	1.610	"	154.75	"	12	3	Some	12	33			
76	Lobulated	" . .	16-19-24	3.7	0–90	1.584	"	62.00	"	3½	3	None	None	33			
77	Nodulated	Inside bloodclot, outside oxalate.	18-31-40	10.2	0–175	1.117	"	39.36	"	2	3	"	"	33			
78	Smooth	Inside uric acid, outside phosph.	28-36-44	25.5	1–56	1.368	"	117.61	"	4½	2	"	"	33			
79	Mammillated	Oxalate . .	14-20-25	2.2	0–52	1.505	"	15.74	"	1	Many	"	"	33			
80	Smooth	" . .	22-45-46	22	0–457	1.353	"	72.00	"	2	2	"	"	33			
81	Rough, mammillated	" . .	9-12-18	1.3	0–19	1.008	"	21.00	Radiating	1½	Many	"	"	33			
82	Smooth	Phosphate . .	18-19-22	3.6	0–56	1.013	Intermediate	49.50	Coincident	1½	2	"	"	33			
83	"	Uric acid . .	17-23-30	6.5	0–129	1.292	Short	57.00	"	2½	2	"	"	33			
84	Nodulated	Oxalate . .	23-26-32	9.1	0–245	1.753	"	162.36	"	9	2	"	"	33			
85	Smooth	" . .	26-32-50	24	0–410	1.107	"	89.11	"	3½	2	"	"	33			
86	"	Combustible, further examination necessary.	35-38-46	27	0–429	1.034	"	34.12	"	1	2	"	"	33			
87	Mammillated	Oxalate . .	10-13-19	1.4	0–26	1.209	"	89.11	Radiating	4	3	One	6	33			
88	Nodulated	Phosphate . .	16-22-27	5.1	0–107	1.366	"	91.50	"	5	4	None	None	33			
89	Smooth	" . .	18-26-32	8.2	0–170	1.351	"	103.37	"	5	Many	"	"	33			
90	"	" . .	26-36-47	23	0–405	1.147	"	31.50	Coincident	1	2	"	"	33			
91	"	Oxalate . .	16-21-30	5	0–99	1.238	"	36.74	Crucial	3½	Many	"	"	33			
92	"	" . .	22-28-32	9.8	0–252	1.675	"	135.75	Coincident	8	2	"	"	33			
93	Rough, mammillated	" . .	16-27-32	6.7	0–141	1.379	"	26.24	"	1½	2	"	"	33			
94	Smooth	Phosphate . .	10-13-25	1.8	0–38	1.375	"	49.50	"	2	2	"	"	33			
95	Nodulated	Inside uric acid, outside oxalate mixed with uric acid.	22-24-27	7.7	0–192	1.624	"	185.74	"	7½	3	Two	24	33			
96	Mammillated	Phosphate with small amount of oxalate mixed in	15-16-26	2.9	0–54	1.218	"	44.50	Radiating	2	Many	None	None	33	None	None	Jefferson Medical College.
97	Smooth	" " "	8-9-10	0.3	0–7	1.520	"	15.74	"	¾	"	"	"	33			
98	"	" " "	7-8-9	0.2	0–4	1.302	"	31.50	"	1½	"	"	"	33			
99	"	Inside uric acid, outside phosph.	16-18-29	4.9	0–86	1.143	"	36.74	Coincident	1	2	"	"	33			
100	"	Oxalate . .	17-20-23	4.1	0–93	1.477	"	89.11	"	5	2	"	"	33			
101	Nodulated	" . .	18-30-35	8.6	0–202	1.537	"	98.61	"	4¼	2	"	"	33			
102	Rough, nodulated	" . .	21-22-24	4.4	0–106	1.584	"	210.00	"	13	2	One	72	33			
103	Mammillated	Inside uric acid, outside oxalate. and phosphate.	13-21-30	4.5	0–97	1.418	"	74.50	Radiating	3	Many	None	None	33			
104	Rough	Oxalate . .	18-21 27	4.6	0–125	1.770	Intermediate	126.75	Coincident	5	2	"	"	33			
105	Smooth	Fatty substance inside, outside oxalate.	12-13-14	1.6	0–33	1.343	"	98.61	Radiating	4	3	One	12	33			
106	Rough	Oxalate . .	16-35-39	10.3	0–227	1.435	Short	93.87	"	3½	3	None	None	33			
107	Smooth	Uric acid . .	23-33-40	18.3	0–458	1.630	"	140.25	"	3	Many	"	"	33			
108	"	" " . .	22-32-40	17.3	0–437	1.645	"	77.00	"	2½	"	"	"	33			
109	Rough	Phosphate . .	18-22-34	7.3	0–138	1.231	"	89.11	Coincident	3	2	"	"	33			
110	Smooth	Oxalate . .	43-53-70	79.5	3–336	1.302	"	129.00	"	4	Many	"	"	33			
111	"	Phosphate . .	33 34-39	23.8	0–448	1.253	"	72.00	"	2	2	"	"	23			
112	"	" . .	23-25-26	7.6	0–141	1.208	"	47.00	"	1½	3	"	"	33			
113	"	" . .	21-22-36	7	0–133	1.247	Intermediate	49.50	"	1	2	"	"	33			
114	"	" . .	22-23-25	6.9	0–130	1.227	Long	36.74	"	1	3	"	"	33			
115	"	" . .	19-20-29	6.5	0–112	1.122	"	53.00	"	1½	3	"	"	33			
116	"	" . .	15-17-30	4.5	0–80	1.158	Short	31.50	"	1	2	"	"	33			
117	"	" . .	13-15-24	2.7	0–42	1.013	"	34.12	"	1	2	"	"	33			
118	"	" . .	12-15-17	1.9	0–30	1.371	"	26.24	Radiating	1	Many	"	"	33			
119	Rough	" . .	12-20-28	4.1	0–67	1.064	"	39.36	Coincident	2	2	"	"	33			
120	Smooth	Uric acid . .	22-38-58	31	1–275	1.586	"	126.75	Radiating	5	4	"	"	33			
121	"	Oxalate . .	15-20-28	5.1	0–98	1.124	"	36.74	Coincident	1	3	"	"	33			
122	Nodulated	" . .	16-23-30	6.3	0–171	1.768	"	162.36	"	6	2	"	"	33			
123	"	" . .	26-34-44	21	1–97	1.789	"	93.87	Radiating	4	Many	"	"	33			
124	Rough, mammillated	Phosphate . .	20-22-44	8.5	0–173	1.325	"	133.50	Coincident	6	4	"	"	33			
125	" "	" . .	15-17-20	2.7	0–44	1.061	"	44.50	"	1	3	"	"	33			
126	Smooth	" . .	12-19-24	3.2	0–67	1.364	"	74.50	Radiating	4	3	"	"	33			
127	Lobulated	Inside uric acid, outside oxalate.	17-25-30	8.3	0–237	1.860	"	179.36	Coincident	15	3	One	6	33			

No.	Appearance of calculus.	Composition of calculus.	Diameters, in millimeters.	Volume, in cubic centimeters.	Weight, in ounces and grains.	Specific gravity (approximate).	Axis of holding between jaws of lithotrite.	Actual crushing resistance of calculus, in lbs., with Forbes' lithotrite; friction of lithotrite and testing apparatus deducted.	Direction of fracture to line of force applied.	Time slowly increasing pressure was applied to calculus, in min.	Number of fragments.	Flying fragments.	Distance fragments were thrown, in inches.	Size of lithotrite used (French scale).	Impaction of lithotrite, measured by increased size, in degrees of French scale.	Point of fracture in lithotrite.	Calculus loaned by
128	Smooth	Phosphate . .	23-29-41	16.8	0–316	1.225	Short	98.61	Coincident	2½	2	None	None	33			Jefferson Medical College.
129	Nodulated	Oxalate . .	13-22-25	4.9	0–113	1.502	"	242.61	Crucial	10	5	"	"	33			
130	Mammillated	" . .	7-11-16	0.7	0–16	1.498	"	49.50	Radiating	1	4	"	"	33			
131	"	" . .	11-13-17	1.3	0–26	1.302	"	39.36	Coincident	1	3	"	"	33			
132	Rough, nodulated	" . .	25-30 35	12.5	0–335	1.745	"	147.00	"	6	2	One	6	33			
133	Coral shape.	" . .	32-41-44	25	1–223	1.832	"	280.00	"	11	2	None	None	33			
134	" "	" . .	31-37-40	19	1–40	1.782	"	390.00	"	14	2	One	72	33			
135	Granulated	Phosphate with oxalate.	42-50-67	65	2–462	1.427	"	206.00	"	5	2	None	None	33			
136	Mammillated	Inside oxalate, outside phosph.	14-19-24	3.1	0–72	1.513	"	98.61	Radiating	3½	Many	"	"	33			
137	Crystalline	Oxalate . .	19-30-34	9.2	0–242	1.713	"	222.00	Coincident	9½	2	One	12	33			
138	Smooth	Phosphate with oxalate.	13-25-35	6.6	0–155	1.520	"	64.50	"	2½	3	None	None	33			
139	"	Inside uric acid, outside phosph.	25-31-45	18.4	0–385	1.352	"	64.00	"	2	2	"	"	33			
140	"	Inside oxalate, outside phosph.	20-30-36	12.4	0–321	1.686	"	124.50	"	6	2	"	"	33			
141	Rough, mammillated	Oxalate . .	20-30 42	12.3	0–264	1.398	"	89.11	"	2½	2	"	"	33			
142	Mammillated	" . .	9-11-16	0.8	0–16	1.302	"	47.00	Radiating	3	Many	"	"	33			
143	Nodulated	" . .	10-12-14	0.9	0–22	1.592	"	39.36	"	1	"	"	"	33			
144	Smooth	Phosphate . .	5- 6-11	0.2	0–5	1.622	"	26.24	"	1	2	"	"	32			
145	Rough	Phosphate with little oxalate.	10-16-18	1.9	0–31	1.062	Intermediate	31.50	Coincident	1	2	"	"	33			
146	Smooth	Phosphate with little oxalate.	8-10 12	0.4	0–8	1.305	Short	18.36	Radiating	¾	Many	"	"	33			
147	"	Oxalate . .	10-13-15	1.4	0–23	1.070	"	39.36	"	1½	"	"	"	33			
148	Rough	" . .	12-16-22	2.5	0–44	1.143	"	21.00	"	¾	"	"	"	33			
149	Shell	" . .	8-14-22	0.4	0–19	1.428	"	5.24	"	¼	"	"	"	33			
150	Smooth	Phosphate . .	41-43-50	48.5	2–288	1.509	"	238.87	Coincident	8	"	Some	30	33			
151	"	Phosphate with piece of iron in center.	26-31-46	20	0–451	1.468	"	89.11	"	2¼	2	None	None	33			
152	"	Oxalate . .	24-35-40	19.3	1–1	1.623	"	142.50	"	4	3	"	"	33			
153	Granulated	" . .	44-52-60	65.5	3–260	1.690	"	133.50	"	4	2	"	"	32			
154	"	Inside carbonate of lime, outside oxalate.	53-63-85	130	6–313	1.600	"	152.50	"	4	2	"	"	33			
155	Smooth	Uric acid . .	32-39-69	42.5	2–121	1.655	"	260.75	"	14	3	One	10	33			Dr. Reckefus, Jr.
156	"	Phosphate . .	16-27-38	9.2	0–171	1.232	"	57.00	"	1½	2	None	None	33			Dr. O. Horwitz.
157	"	Uric acid . .	13-17-21	3.3	0–57	1.125	"	82.00	"	2½	2	One	10	33	None	None	
158	"	" " . .	12-17-18	2.7	0–46	1.106	"	79.50	"	2	2	None	None	33			
159	"	" " . .	11-16-20	2.5	0–44	1.146	"	91.50	Crucial	3	4	One	12	33			
160	"	" " . .	20-31-42	15.5	0–392	1.649	"	52.00	"	1	3	None	None	33			
161	Mammillated	Phosphate . .	18-21-33	10.6	0–187	1.149	"	126.75	"	5	4	Two	20	33			
162	"	Oxalate . .	17-23-28	6.4	0–149	1.517	"	210.00	"	14	5	None	None	33			
163	Smooth	Inside oxalate outside phosph.	21-31-38	14	0–313	1.456	"	79.50	Coincident	3	2	"	"	33			
164	Smooth and nodulated	Oxalate . .	21-29-36	11	0–267	1.581	"	77.00	Crucial	3	3	"	"	33			
165	Smooth	Uric acid . .	17-34-42	13.1	0–291	1.447	"	117.61	Coincident	4	2	One	12	33			
166	Mammillated	Inside uric acid, outside oxalate.	15-20-23	3.6	0–81	1.466	"	109.11	Crucial	3	5	None	None	33			
167	Smooth	Phosphate . .	27 28-40	15.6	0–268	1.119	Intermediate	21.00	Coincident	1	2	"	"	33			
168	"	Uric acid mostly, outside uric acid mixed with phosphate and oxalate.	24-41-55	27.5	1–102	1.378	Short	69.50	"	1½	2	"	"	33			
169	"	Phosphate . .	32-42-50	37.5	1–262	1.288	"	59.50	"	4	4	"	"	33			Dr. J. A. Peoples.
170	"	Oxalate . .	27-47-53	38.5	1–420	1.523	"	98.61	"	4	5	"	"	33			Dr. Jos. Hearn.
171	Granulated	Phosphate . .	32-40-60	38.2	1–367	1.444	"	59.50	"	2	2	"	"	33			
172	Smooth	Center oxalate, intermediate layer uric acid, outside phosph.	44-52-67	84.5	3–446	1.454	"	101.00	Radiating	4	Many	"	"	33			
173	Nodulated	Uric acid . .	31-37-43	30	1–281	1.652	"	338.24	Coincident	5	2	"	"	33			
174	Smooth	Phosphate . .	8-15-16	1	0–22	1.433	"	34.12	"	1	3	"	"	33			Jeff. Med. Coll.
175	"	Inside uric acid, outside phosph.	25-25-31	9.3	0–160	1.120	"	72.00	Radiating	3	Many	"	"	33			Dr. A. Hewson.
176	"	Phosphate . .	15-22-30	4.7	0–104	1.441	"	39.36	Coincident	1	2	"	"	33			Dr. W. S. Forbes.
177	"	Oxalate . .	29-42-51	37	1–471	1.674	"	82.00	Radiating	2	Many	"	"	33			Dr. A. Hewson.
178	"	Uric acid with little oxalate.	15-18-27	4.1	0–92	1.461	"	42.00	Crucial	1	5	"	"	33			Dr. Jos. Hearn.
179	Rough	Phosphate . .	13-19-26	2.9	0–72	1.617	"	7.86	"	½	Many	"	"	33			
180	Smooth	Uric acid . .	14-15-16	2	0–50	1.625	"	26.24	"	1	"	"	"	33			
181	"	" "	13-15-17	1.9	0–49	1.680	Long	49.50	"	1½	"	"	"	33			
182	"	" "	13-14-17	1.8	0–45	1.628	Short	86.74	"	3	"	"	"	33			
183	"	Inside uric acid, outside oxalate.	13-15-16	1.6	0–44	1.791	"	86.50	"	2½	"	"	"	33			
184	"	Oxalate . .	13-14-16	1.4	0–37	1.721	"	49.50	"	1½	"	"	"	33			

NOTE.—I am indebted to Professor Henry Leffmann, M.D., Pathological Chemist to Jefferson Medical College Hospital, for the chemical analysis of these vesical calculi.

Attention is called to the large percentage of oxalate of lime calculi. This is probably accounted for from the fact that they had been especially cared for by their collectors, while other stones not receiving such attention were lost.

I have attempted to deduce from this table a general law for the crushing resistance of vesical calculi, considered under the heads of chemical composition, weight, size, and specific gravity, but owing to the great variation in the ages of the calculi since being removed from the bladder (from one to seventy years) and the consequent hardening or softening of the colloids due to atmospheric exposure, it has been found impracticable for the present at least. It would seem, however, as one element of the law, that there is a marked decrease in the crushing resistance of vesical calculi relatively to their size and weight as they grow larger.

The crushing resistance and other physical properties such as size, weight, etc., of the calculus are as much as its chemical composition a part of its clinical history. Hereafter by the use of this new lithotrite, having the measuring mechanism in its handle, the crushing resistance of a calculus will be recorded at the time of the operation.

Thus, in time a table may be compiled from the reports of observing lithotritists which will enable a more judicious selection of a lithotrite of proper size for the reduction of a given calculus.

It is my purpose to demonstrate from experiments the relative crushing resistance of vesical calculi and the strength of the new lithotrite. The line of safety in this new lithotrite will be pointed out by having stamped on its handle, with the maker's name, the number of pounds to which the instrument has been safely tested in a machine which has been made for this purpose, before it leaves the maker's shop.

The testing machine and the lithotrite were designed and made by my son, Mr. John S. Forbes, engineer.

I will venture to ask permission to allow him to describe them.

TESTING APPARATUS. (BY MR. JOHN S. FORBES.)

This apparatus (Fig. 1) consists first of a rigid frame of wrought-iron pipe, A; second, of a longitudinally adjustable cast-iron bridge, B, spanning the frame and secured at any point by clamps, C C. Mounted on this bridge is a universal brass clamp, D. for holding the cylindrical handle of the lithotrite.

A cast-iron bed-plate, E, spans the frame and is secured at one end of it. This bed-plate carries a rotatable shaft, F, turning in ball-bearings, whereby the friction is reduced to a minimum. This shaft also has an end movement of about one and a quarter inches. One end of the shaft is provided with an independent four-jaw chuck, G, for holding and turning the screw-handle of the lithotrite. Upon the middle portion of the shaft, and between the ball-bearings, is a flat, grooved, brass wheel, H, so arranged that it may be turned independently of the shaft or locked to it. Secured to the wheel is a cord, I, which passes over an overhead grooved pulley, J, and is provided at its dependent end with a pan, K, for the reception of weights. The friction due to turning the wheel and its accompanying parts, and weight of the pan is eliminated by the small bottle, L, containing shot. The operation of the apparatus is as follows:

A lithotrite is placed in position and its cylindrical handle clamped with the brass clamp, D, on the cast-iron bridge. The screw-handle is secured in the four-jaw chuck, G, on the rotatable shaft, and the whole is gotten in perfect line and accord. By locking the instrument and turning the wheel, H, over to the right, the male jaw of the lithotrite is propelled toward the female jaw, and by unlocking the instrument the male jaw, together with the shaft, chuck, and wheel, may be slid backward and forward just as the instrument may be operated in the hands. The result so far, then, is that we have a lithotrite held in an apparatus, and the objects are: first, to measure the crushing resistance of a calculus placed between the jaws of the lithotrite; second, to learn what pressure may be obtained between the jaws of the lithotrite without injury to them or any other portion of the lithotrite; and third, what pressure between the jaws will break them or any other part of the lithotrite. In order to obtain the crushing resistance of a calculus held between the jaws of a lithotrite we must consider mathematically the mechanical elements of the testing apparatus and the lithotrite.

We may use the formula:

$P = p \times c \times w$ in which $P =$ equals the pressure between the blades; $p =$ the pitch of the screw in number of turns per inch; $c =$ the circumference of the wheel, H, of testing apparatus; $w =$ the weight in the pan, K, of the testing apparatus.

Thus it will be seen that the forces are inversely as the paths.

Now this will give us the theoretical pressure between the jaws, but we must consider the friction in the lithotrite arising from the screw-thread and the tendency of the male blade to buckle. In order to obtain this friction we place a dynamometer, or other pressure-recording instrument, between the jaws and apply weights to the pan of the testing apparatus. In this way we will get the coefficient or ratio of friction in the lithotrite to the weight applied for various pressures between the jaws. We can therefore lay out a table of actual frictions for each pressure. The formula must now have the factor of friction introduced, and it may be expressed thus:

$P = (p \times c \times w) - (F\,w)$ wherein $F =$ the friction corresponding to the weight, w. The dynamometer is now removed and we are ready to measure the crushing resistance of any given calculus. The table of crushing resistance of vesical calculi which is before you was obtained in this way. In order to obtain the second and third objects, viz: the pressure which may be obtained between the jaws of the lithotrite without injury to any part of the in-

*

strument, and what pressure and where the instrument will first give way, we again make use of the dynamometer and apply weights to the pan of the testing apparatus until something happens, for something is bound to occur if we apply enough weights. The dynamometer ceases to move when this event takes place, and we read the ultimate pressure which the now useless lithotrite was able to record. In this manner the table of the strength of various lithotrites which is before you was obtained.

DESCRIPTION OF LITHOTRITE. (BY MR. JOHN S. FORBES.)

This lithotrite (Fig. 2) has some of the elements that are common to the Civiale, Thompson and

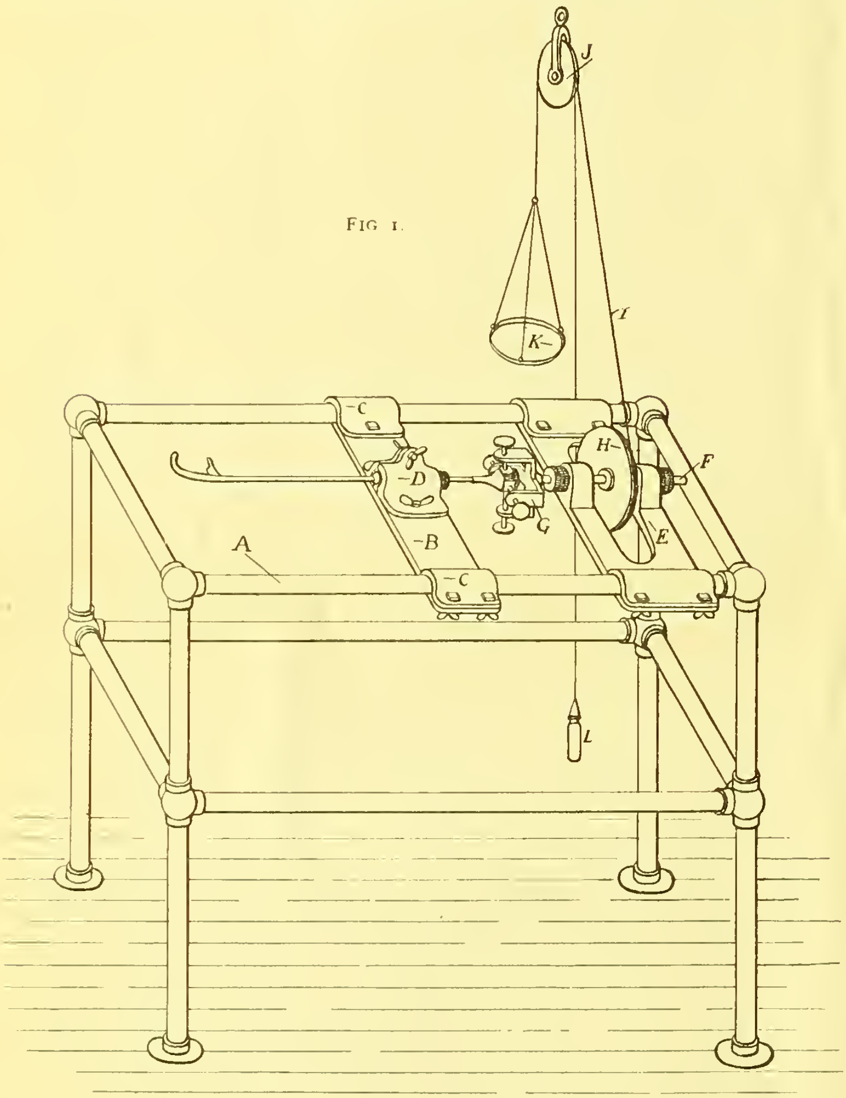


Fig. 1.

Fig. 5.

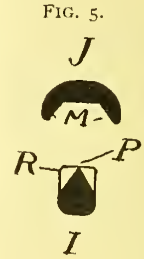


Fig. 6.

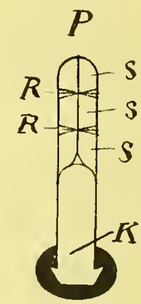


Fig. 7.

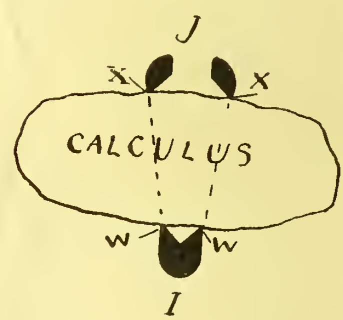


Fig. 8.

Fig. 2.

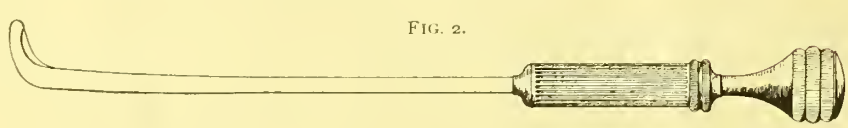


Fig. 3.

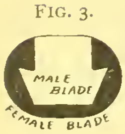
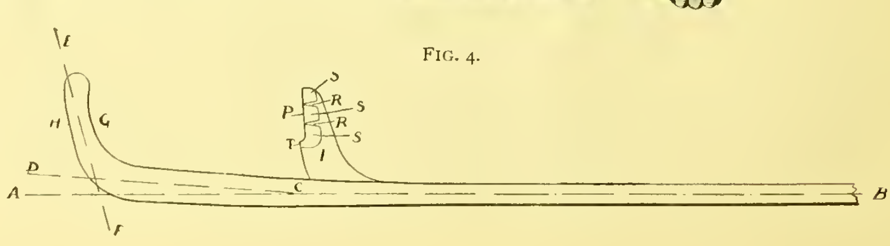


Fig. 4.



Bigelow instruments, viz: a pair of jaws capable of being separated and brought together and a handle mechanism for their operation. The construction and general lines of it are, however, entirely original and widely different from any lithotrite now in existence. It may be thus described:

The penile and vesical end consists of a male blade sliding within a female blade and held within the latter by means of a slightly angular under-cut slot, Fig. 3.

This is done to prevent the male blade rising out of the female when under a strain, so that the greater the strain the tighter the male blade is held within the female. The long axis, E C, Fig. 4, of the shaft is straight from the handle to within about two inches of the crook or curve; here it rises, C D, at an angle of about five degrees until it meets the curve.

This accomplishes six important objects: First, it gives an easy introduction of the instrument through the urethra, because of a wide angle. Second, it increases the strength of the female jaw by giving it support higher up. Third, it allows a larger stone to be grasped without incurring a long female jaw. Fourth, it places the metal of the female shaft where it is most needed to give strength. Fifth, it prevents side movement or twisting of the male jaw by giving it a deeper slot to move in, and thereby supporting it higher up, for the male blade works in a straight slot along the axis, A C E. Sixth, the angle between the axis, E F, of the female jaw and the long axis of the shaft, A C B, is the same as if the shaft were straight all the way to the curve.

The female jaw has its proximal surfaces concave, G, preventing the calculus from slipping out when the power is applied, and tending as well to drive the calculus lower down, thereby placing it in a position where the instrument gains strength. The female shaft is elliptical and of uniform size from the handle up to within about three inches of the crook; here it begins to increase slightly in caliber until it reaches the maximum which is at the crook (Fig. 4). This results in great strength for the female shaft at the point where it is most needed, and at the same time places the extra metal within the bladder and within the prostatic portion of the urthera only, where it is easily accommodated.

The shoe of the female jaw (M, Fig. 5) is made abundantly larger than the male jaw, so that all débris is expelled, and impaction of the instrument prevented, and the wall of the bladder is thus protected from being pinched or cut (Fig. 5). The female blade is elliptical in cross-section (Fig. 6), in order to give a thick septum, K, to the male blade, and yet not increase the caliber of the shaft (Fig. 6). The female jaw is made thin in a fore-and-aft direction (G, H, Fig. 4), in order to take up less room in the bladder. The proximal surface (P, Fig. 5) of the male jaw is in the form of a wedge of about sixty degrees, in order to penetrate a calculus with the least power propelling it. The cross ridges (R, R, Figs. 4, 5, 6) prevent the stone from flying when broken, and the parallel spillways (S, Fig. 4, 6) permit the débris to escape without causing impaction of the instrument.

Sir Henry Thompson, in his book (*The Urinary Organs*, note 1, page 79), says: "Only slight approximation to the form of the wedge in the opposing surface of the male blade is permissible. If it has an angle, say, of ninety degrees, some danger is incurred. It may be driven through almost any stone, it is true, but the fragments will fly off right and left with prodigious force, even in fluid, and injure the coats of the bladder. Also, when the male blade has the form of a rather sharp wedge, the calculus is seized, and retained with greater difficulty than with a male blade which is less salient."

Perhaps he does not realize it, but after saying the foregoing he has deliberately designed and adopted a wedge in his instrument of less than ninety degrees; in fact, a wedge of forty-five degrees, with no means whatever beyond it to prevent the fragments flying (W, W, Fig. 7). A great deal of the success of his instrument is owing to the sharp wedge, of which he is evidently not aware, for it allows his instrument to cleave a stone with less force propelling it, and when anything is disrupted with a small force the energy stored up in the parts so separated is less, and they will come to rest sooner. The iceman, with a thin-bladed axe, splits the block of ice gently and with ease, and the parts so separated do not fly. What would happen if he used the broad head of an axe?

As regards the alleged difficulty of seizing and retaining a calculus with a sharp single wedge, it is a well-known fact that an uneven object adjusts itself more readily to three points of contact than four. More especially is this true when the three points form apices of a triangle. Moreover, it may be said that out of 184 vesical calculi crushed by this lithotrite in the testing apparatus, not one slipped in the least, except to adjust itself lower down on the female jaw, owing to the concave surface of that member, as already mentioned. I greatly doubt if all four of the opposing edges (W, W, X, X, Fig. 7) in the Thompson lithotrite are at the start in contact with a calculus.

The spur (T, Fig. 4) rises to a great height on the male jaw to give it greater strength. This spur interferes in no way with the holding of the stone.

The great breadth of the septum (K, Fig. 6) of the male blade is permitted by the elliptic shaft.

The handle or screw mechanism belongs to what is known as the interrupted screw-type. It consists of an internally screw-threaded barrel (Fig. 8) having the threads cut away for the entire length of the barrel at alternate spaces of ninety degrees each.

This screw-barrel has an end movement in the cylindrical handle of about one-sixteenth of an inch. Working in this barrel is a pair of screw-blocks, likewise having their screw-threads interrupted at alternate spaces of ninety degrees each. Thus the screw-blocks may be slid up and down the barrel without the threads engaging. When it is necessary, however, to apply the power, the screw-blocks are turned by means of the screw-handle, and the threads engage immediately. One screw-block is rigidly keyed to the screw-handle shaft, and the

other is so formed that it may have a motion of ninety degrees around the screw-handle shaft. Thus, when the screw-handle shaft is turned to the right the screw-block that is rigidly attached to the shaft is brought into mesh with the threads of the screw-barrel, and a further turn of the handle of ninety degrees brings the rotatable screw-block also into mesh. The screw-threads on these two blocks are, therefore, now no longer interrupted, relatively to the barrel, but continuous, and we have in substance a solid plug, or screw-block, engaged with the threads in the screw-barrel. As long as the screw-handle is turned to the right this state of affairs continues, and the male jaw is propelled toward the female jaw. After the calculus is crushed the instrument may again be unlocked and the jaws separated by turning the screw-handle to the left until it stops. This left-hand motion is never more than half a turn. Owing to the sixteenth-inch play of the screw-barrel in the cylindrical handle it readily adjusts itself to engage with the thread of the screw-block, and the calculus is, therefore, never dropped (perhaps after a hard search for it) in locking the instrument. The screw-thread of this instrument has been made slow for several reasons. First, it increases the power of the instrument for crushing, because it brings in the well known and important factor of time in crushing the calculus. A certain pressure may be applied to a stone without crushing it, but if the same pressure is allowed to remain acting upon the stone for a short time the stone will crumble without the addition of further pressure. The slow thread is, therefore, adopted that the stone may have time to break without unduly straining the instrument. The operator is also spared using an

TABLE OF COMPARATIVE EFFICIENCY OF LITHOTRITES.

No.		Kind of lithotrite.		
		Forbes.	Bigelow.	Thompson.
1	Size of lithotrite—French scale	No. 33	No. 33	No. 29
2	Pitch of screw (in turns per inch)	14	4.57	4
3	Character of screw-thread	Single	Triple	Quadruple
4	Diameter of screw-handle in inches	1.625	1.3125	1.3125
5	Theoretical pressure, in pounds, between jaws of lithotrite for one pound in pan of testing apparatus (wheel of apparatus being 18″ in circumference)	252	82.27	72
6	Actual pressure, in pounds, between jaws of lithotrite for first pound in pan of testing apparatus, as registered by dynamometer	42	32	30
7	Per cent. of friction in lithotrite for first pound applied; the actual friction increases by an almost constant increment for increased loads for all types of lithotrites	83.3	61	58.25
8	Constant, for decrease of pressure between jaws of lithotrite, for each additional pound applied to the pan of testing apparatus	1	0.5	0.5
9	Average crushing resistance of ten plaster-of-Paris cylinders of uniform size. All crushed through same axis to determine the comparative penetrative qualities of the various lithotrites. Actual effort in pounds between jaws	128 64	156.48	147.50
10	Relative penetrative efficiency, due to the form of jaws, as deduced from No. 9, compared with the Forbes lithotrite	1.000	0.822	0.872
11	Actual pressure, in pounds, between jaws of lithotrite for first pound of rotative force applied to screw-handle	11.93	7.34	6.88
12	Constant for decrease of pressure between jaws of lithotrite, for each additional pound of rotative force applied to screw-handle	0.28	0.11	0.11
13	Relative crushing effect of lithotrites on a calculus for first pound of rotative force applied to screw-handle, deduced from Nos. 10 and 11	1.000	0.505	0.502
14	Relative operative strength of lithotrites as deduced from their penetrative efficiency and gross strength	1.000	0.661	0.652 No. 33 F.

TABLE OF COMPARATIVE STRENGTH OF LITHOTRITES.

Kind of lithotrite.	Size of lithotrite, French scale.	Greatest pressure, in lbs., from which lithotrite would recover shape, or remain operative	Ultimate pressure, in lbs., required to bend, break, or make lithotrite inoperative.	Effect of ultimate pressure.	Shown in
Forbes	No. 33	600	650	Female shaft bent down 1¾″ from end; ends of flanges of male jaw slightly torn; instrument can be closed completely and withdrawn from bladder	Fig. 9
Forbes	No. 29	484	525	Instrument this size not tested; figures were calculated and therefore only approximate.	
Bigelow with Forbes male proximal surface and V groove	No 26	345	358	Female shaft slightly bent down 1¾″ from end; female jaw broken through on one side of fenestrum; instrument can be closed and withdrawn from bladder.	Fig. 13
Bigelow	No. 33	483	495	Male jaw snapped off at top of spur with great force, flew 12 feet; locking rods in handle slightly bent; instrument can be closed and withdrawn from bladder.	Fig. 10
Bigelow	No. 29	381	400	Male jaw snapped off at crook with force; female jaw snapped off near top of fenestrum with force; instrument can be closed and withdrawn from bladder.	Fig. 11
Thompson	No. 33	449	472	Instrument this size not tested; figures were calculated, and are therefore only approximate.	
Thompson fenestrated	No. 29	355	382	Female shaft badly bent down 1¾″ from end; screw thread slightly burred; instrument cannot be closed within 1½″.	Fig. 12

NOTE.—The conditions of these tests were identical, and the resistance of the dynamometer was applied between the extreme ends of the jaws. The Forbes and Bigelow instruments were made by Tiemann & Co., of New York, and the Thompson fenestrated by Weiss, of London.

undue amount of strength, for with him it is the old story of 33,000 pounds one foot high in one minute, or one pound 33,000 feet high in one minute. The screw-handle has been made larger than heretofore, because it has been ascertained that any stone will give way before the instrument suited to it is damaged, and a large screw-handle aids the easy and gentle manipulation of the instrument. The shape of the handle is also different, and calculated to serve its purpose. Being made of very thin sheet-metal it is at once strong, and as light as the lightest handle now employed, which is, perhaps, the soda-water-fountain wheel of Thompson or Civiale. I have designed a mechanism which may be placed within the hollow screw-handle, whereby the operator can see what power he is exerting between the jaws of the lithotrite. This mechanism, though it will add a trifle to the weight of the lithotrite, will not increase its size in any part. To sum up this instrument, it may be likened to a chain in which each link is of equal strength, and that means the maximum strength for a given size and weight, or, in other words, a correct disposition of metal.

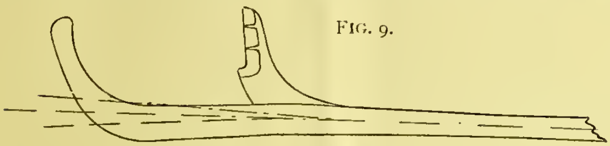


FIG. 9.

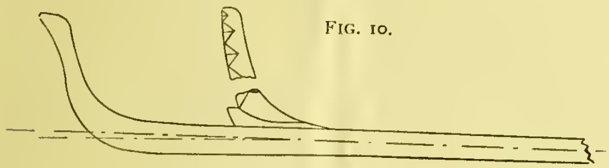


FIG. 10.

Messrs. George Tiemann & Co., of New York, will make this instrument, and it is proposed to place this testing apparatus in their workshop, where every instrument, will, before it leaves the shop, be tested to a proper pressure in accordance with its size, and the pressure it has been so subjected to stamped plainly upon the handle. Thus the surgeon may operate with the greatest confidence in his lithotrite, knowing the pressure it has been subjected to and the crushing resistance of the hardest calculus thus far obtained by us, as indicated in the table.

As a final result of this series of experiments, which have been conducted with the utmost care and impartiality, we may draw several conclusions. First, as regards the lithotrite, its shape and action: After seven operations on the living subject it has demonstrated its complete fitness. It has broken a hundred and fifty-eight calculi while in the testing apparatus, and it has been subjected to a pressure of five hundred pounds between the jaws for thirteen times. Its ultimate strength after this trying ordeal was six hundred and fifty pounds, and, moreover, after this enormous pressure the instrument was closed and could have been introduced and withdrawn from a human bladder with ease and without injury to the parts. As regards the calculi crushed to make the table which is before you, it may be stated that the large majority were many years old and much harder than they would have been if only recently taken from a living subject. The greatest resistance offered by any calculus so far encountered by us was four hundred and six pounds. (No. 27.)

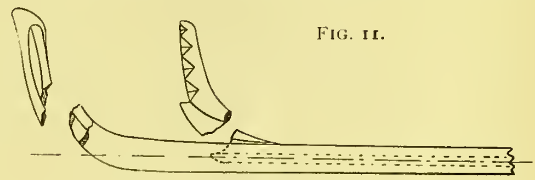


FIG. 11.

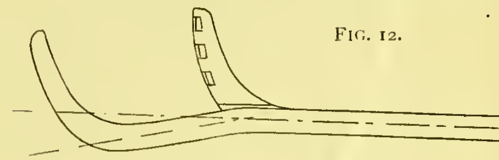


FIG. 12.

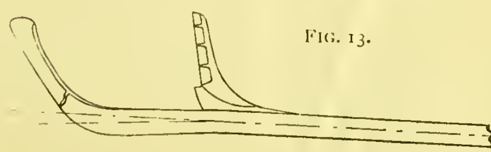


FIG. 13.

SYNOPSIS OF CONSTRUCTION OF THE LITHOTRITE. READ BY DR. W. S. FORBES.

1. Designed with the view of meeting, first, the anatomical conditions; second, conforming to the laws of mechanics, special attention being given to the economic disposition of material.

2. Double curve, permitting easy introduction, giving greater strength to the female shaft and jaw, and better support to resist side movement of the male jaw.

3. Elliptic cross-section of the shaft, to give greater breadth of septum, prevent side movement of the male jaw, and be of minimum circumference.

4. Angular undercut slot or V groove, to prevent the male blade from rising out of the female shaft and to bind the two closer together under strain.

5. Concave shape of the female proximal surface, to prevent the calculus slipping out, as well as to drive it down to the lower part of the curve and so gain strength for the female jaw.

6. The female jaw made flat in a fore-and-aft direction, to take up a minimum amount of room in the bladder.

7. Large clearance between the outside of the male jaw and the inside of the female jaw, to prevent injury to the bladder, and impaction.

8. All exposed edges gently rounded to prevent injury to the bladder.

9. All internal corners rounded to avoid starting cracks.

10. Shape of the male proximal surface strategic, *i. e.*, best adapted to the more easily penetrate a calculus, to keep fragments from flying and clear itself, to prevent impaction.

11. Plea for the slow thread (strain on the instrument and work done by operator reduced to a minimum and time gained).

12. Plea for the large screw-handle; it is not too large because few men can break an instrument with it; moreover, the instrument as constructed will break any calculus before it is injured itself. Metallic, hollow, and very light.

13. Interrupted screw-mechanism. It is stronger, less complicated, and easier to operate.

14. Cylindrical handle, same size as Bigelow's, and of proper size to allow of holding tightly.

15. Power-recording mechanism in screw-handle, to measure strain on lithotrite and crushing resistance of calculus.

16. The size of the instrument is one and three-quarter inches shorter than the Bigelow of equal caliber and opening, and five-eighths of an inch longer than Thompson's of equal caliber and opening.

17. The weight of this instrument is the same as Bigelow's and a trifle more than Thompson's of equal caliber and opening.

Owing to the kindness of Messrs. George Tiemann & Co., of New York, in executing the thoughts of my son and in following his drawings and models in the various evolutions to the final instrument, which is now brought before you, and in supplying the already existing types of instruments for testing, he has been enabled to carry these experiments to a higher degree of refinement than my purse would otherwise have allowed.

During the crushing of these calculi there were present on various occasions the following gentlemen: Dr. G. M. Gould, of The Medical News, Prof. Frederick P. Henry, Prof. Harrison Allen, Dr. A. Hewson, Prof. Joseph Hearn, Dr. Charles H. Reckefus, Jr., all of Philadelphia. During the breaking of the lithotrites in the testing machine there were present Professor Orville Horwitz, and Dr. A. Hewson, Demonstrator of Anatomy, Jefferson Medical College.

A word, and I have done—a word, but a necessary one. I know that I incur the risk of displeasing my son in what I am going to say; but, in this body of men and on this occasion, I trust a father may be pardoned for venturing to digress from the injunction of his son.

In the paper I have had the honor of reading every thought, every idea expressed, indeed, the entire habendum of the paper, came from and belongs to my son, Mr. John S. Forbes, mechanical engineer.

1704 Walnut Street.